CLAIMS

What is Claimed Is:

1. A nerve stimulator needle apparatus comprising:

a needle capable of carrying an electric current;

a variable control mechanism which is operable to variably control the amplitude of an application of electric current to said needle;

a plurality of electrical connectors connected to said variable control mechanism and said needle which allows said variable control mechanism to remotely connect to a nerve stimulation device which is operable to provide a voltage to said variable control mechanism and to provide a current pulse to said needle having an amplitude which is controlled by said variable control mechanism; and

a housing which holds said variable control mechanism, said plurality of electrical connectors and said needle.

2. The nerve stimulator needle apparatus of claim 1, wherein said needle is a hypodermic needle, said apparatus further comprising:

an injection tube operably connected to said needle to provide a fluid to said needle.

3. The nerve stimulator needle apparatus of claim 2, wherein said housing includes a fluid path, and said injection tube is connected to one end of said fluid path and said needle is connected to another other end of said fluid path.

4. The nerve stimulator needle apparatus of claim 1, wherein said variable control mechanism includes a pressure sensitive switching mechanism which changes the amplitude of said current applied to said needle in relation to the amount of pressure applied to said pressure sensitive switching mechanism.

5. The nerve stimulator needle apparatus of claim 1, wherein said variable control mechanism is operable to increase or decrease current to the needle.

6. The nerve stimulator needle apparatus of claim 1, wherein said variable control mechanism is operable to control a rate of change of the current.

7. The nerve stimulator needle apparatus of claim 1, wherein said housing further includes conductive traces which connect said variable control mechanism and said needle to said electrical connectors.

8. The nerve stimulator needle apparatus of claim 1, wherein an electrically resistive layer covers said needle, the resistance of said resistive layer changes with the length of said resistive layer, and an electrical trace from an electrical pin connector provides a voltage to said electrically resistive layer from said nerve stimulator device.

9. The nerve stimulator needle apparatus of claim 8, wherein said needle unit further includes an insulating layer between said electrically resistive layer and said needle.

10. The nerve stimulator needle apparatus of claim 1, wherein said needle unit further includes depth measurement marks which indicate the insertion depth of said needle.

11. The nerve stimulator needle apparatus of claim 1, wherein said variable control mechanism comprises a variable optical switching device.

12. The nerve stimulator needle apparatus of claim 11, wherein said variable optical switching device includes a partially colored plate and a fiber optic cable which directs light from a light source to impinge on said partially

colored plate, and directs reflected light from said partially colored plate to a sensor.

13. The nerve stimulator needle apparatus of claim 12, wherein said partially colored plate alters color or intensity components of the light impinged on it from said fiber optic cable in response to an application of pressure.

14. The nerve stimulator needle apparatus of claim 11, wherein said variable optical switching device includes a graduated reflective plate and a fiber optic cable which directs light from a light source to impinge on said graduated reflective plate, and directs reflected light from said graduated reflective plate to a sensor.

15. The nerve stimulator needle apparatus of claim 14, wherein said graduated reflective plate alters color or intensity components of the light impinged on it from said fiber optic cable in response to an application of pressure.

16. The nerve stimulator needle apparatus of claim 1, wherein said needle is an insulated needle.

17. A nerve stimulator apparatus comprising:

a nerve stimulator device comprising:

a voltage source;

a controller; and

a current source operable to produce an electrical current in response to said controller; and

a needle unit remotely located from said nerve stimulator device and connected to said nerve stimulator device only by at least one electrical conductor, said needle unit comprising:

a variable control mechanism which is operable to receive a voltage from said voltage source and to provide instructions to said controller to variably control the amplitude of said electrical current provided by said current source;

a needle capable of carrying said electric current from said current source having the amplitude controlled by said variable control mechanism; and

a housing which holds said variable control mechanism and said needle.

18. The nerve stimulator apparatus of claim 17, wherein said needle is a hypodermic needle, said apparatus further comprising:

an injection tube operably connected to said needle to provide a fluid to said needle.

19. The nerve stimulator apparatus of claim 18, wherein said housing includes a fluid path, and said injection tube is connected to one end of said fluid path and said needle is connected to another other end of said fluid path.

20. The nerve stimulator apparatus of claim 17, wherein said variable control mechanism includes a pressure sensitive switching mechanism which changes the amplitude of said current applied to said needle in relation to the amount of pressure applied to said pressure sensitive switching mechanism.

21. The nerve stimulator apparatus of claim 17, wherein said current source is operable to increase or decrease current in response to the operation of said variable control mechanism, and said variable control mechanism is operable to increase or decrease current to the needle.

22. The nerve stimulator apparatus of claim 17, wherein the current source changes the amplitude of said current in response to the operation of said variable control mechanism and said variable control mechanism is operable to control the rate of change of the current.

23. The nerve stimulator apparatus of claim 17, further comprising electrical connectors mounted to said housing, wherein the electric current is provided through said electrical connectors.

24. The nerve stimulator apparatus of claim 23, wherein said housing further includes conductive traces which connect said variable control mechanism and said needle to said electrical connectors.

25. The nerve stimulator apparatus of claim 17, wherein said needle unit includes an electrically resistive layer covering said needle, wherein the resistance of said resistive layer changes with the length of said resistive layer, and an electrical trace from an electrical connector provides a voltage from said voltage source to said electrically resistive layer.

26. The nerve stimulator apparatus of claim 25, wherein said needle unit further includes an insulating layer between said electrically resistive layer and said needle.

27. The nerve stimulator apparatus of claim 17, wherein said needle unit further includes depth measurement marks that indicate the insertion depth of said needle.

28. The nerve stimulator apparatus of claim 25, wherein said controller includes a microprocessor, and said microprocessor determines the insertion depth of the needle according to the equation:

$$L_b = (R_t - R_a) / r_L$$

where R_a is the resistance of the portion of the needle protruding above a skin surface of a subject;

R_t is the resistance of the total length of the needle;

r_L is the resistance per unit length of the needle; and

L_b is the insertion depth of the needle.

29. The nerve stimulator apparatus of claim 25, wherein the value R_a is calculated from the ratio of the applied voltage to the resistive layer on the needle divided by the current detected by a return electrode attached to the surface of the skin of a subject.

30. The nerve stimulator apparatus of claim 17, wherein said variable control mechanism comprises a variable optical switching device.

31. The nerve stimulator apparatus of claim 30, wherein said variable optical switching device receives light from a light source and includes a partially colored plate and a fiber optic cable which directs the light from said light source to impinge on said partially colored plate, and directs reflected light from said partially colored plate to a sensor.

32. The nerve stimulator apparatus of claim 31, wherein said partially colored plate alters color or intensity components of the light impinged on it from said fiber optic cable in response to an application of pressure, and said sensor converts said altered color or intensity components to a corresponding current signal.

33. The nerve stimulator apparatus of claim 30, wherein said variable optical switching device includes a graduated reflective plate and a fiber optic cable which directs light from a light source to impinge on said graduated reflective plate, and directs reflected light from said graduated reflective plate to a sensor.

34. The nerve stimulator needle apparatus of claim 33, wherein said graduated reflective plate alters color or intensity components of the light impinged on it from said fiber optic cable in response to an application of pressure.

35. The nerve stimulator apparatus of claim 17, wherein said needle is an insulated needle.

36. A method of locating nerves comprising the steps of:

(A) inserting a needle mounted on a housing through a surface of skin of a subject;

(B) activating a variable control mechanism mounted on said housing to provide a variably controlled current to said needle;

(C) monitoring a detected current signal from a return electrode attached to said surface of skin of a subject using a nerve stimulator device,

wherein steps A and B are substantially performed simultaneously by the same hand of an operator.

37. The method of locating nerves according to claim 36, further comprising the step of determining the needle insertion depth by providing a voltage to a resistive layer, completing a circuit through a return electrode on the skin surface.

38. The method of locating nerves according to claim 37, wherein the step of determining the needle insertion depth is performed according to the equation:

$$L_b = (R_t - R_a) / r_L$$

where R_a is the resistance of the portion of the needle protruding above a skin surface of a subject;

R_t is the resistance of the total length of the needle;

r_L is the resistance per unit length of the needle; and

L_b is the insertion depth of the needle.

39. The method of locating nerves according to claim 38, wherein the value R_a is calculated from the ratio of the applied voltage to the resistive layer on

the needle divided by the current detected by the return electrode attached to the surface of the skin of a subject.

40. The method of locating nerves according to claim 36, wherein the determination of the needle depth comprises the steps of:

continuously applying a constant current to a resistive layer on the surface of said needle;

periodically applying a current pulse to said needle while applying said constant current;

waiting for a period of time to elapse after applying said current pulse to said needle and determining the resistance of the resistive layer of said needle exposed from the surface of skin of the subject; and

calculating the depth of said needle inserted in the surface of skin of the subject.